

Claims 12 to 17, 20 and 22 to 24 were rejected under 35 USC 102 as being anticipated by the Shimoda et al patent and claims 18, 19 and 21 were rejected under 35 USC 103 as being obvious over the Shimoda et al patent taken in view of the Murphy et al patent. The Examiner states that Shimoda et al teaches a heat treatment process for a sulfonated polymeric membrane that is substantially amorphous prior to the heat treatment to increase the degree of crystallinity of the membrane as required in the present claims. The Examiner states that Example 1 shows a heat treatment of a polymeric proton exchange membrane wherein the membrane is immersed in a 60°C solvent for two hours and then in a 200°C solvent for two hours wherein the crystallinity of the membrane increases from less than 10% to 26% by weight and teaches washing the membrane at room temperature after the heat treatment. The Murphy et al patent is cited to show conditioning a polymeric proton exchange membrane for operation at temperatures above 100°C wherein the membrane polymer is a perfluorosulfonic polymer and contends that although Murphy et al does not teach the concentration of carbon monoxide, it does teach that the membrane is used in fuel cells and therefore, it would have been obvious to one skilled in the art to substitute the membrane as taught by Murphy et al for that of Shimoda et al. In response to Applicants' arguments, the Examiner contends that Examples 1 and 3 do not support the recitation of heating the membrane to a temperature of at least 5°C above the operating temperature.

Applicants respectfully traverse these grounds of rejection since the Shimoda et al patent taken alone or in view of the Murphy et al patent in no way anticipates or renders obvious Applicants' invention. The Shimoda et al patent is in no way directed to a membrane for a fuel cell but, rather, relates to a method of making a porous membrane useful for filtration of hot water and radioactive materials as can be seen from lines 16 to 32 of column 25 and lines 25 to 51 of column 33. Membranes for fuel cells are not microporous membranes but, rather, are solid non-porous membranes as can be seen from Murphy et al cited by the Examiner. Applicants' membranes are solid without any holes therein which is necessary to obtain the electrochemical potential. Any holes through which water can flow permit a short circuit thereof.

In Applicants' membrane, the protons permeate the membrane by moving through water-bound to the sulfate groups of the membrane whereas Shimoda et al describes a microporous membrane used for filtration and it would not perform without a plurality of holes. The two technologies are completely non-analogous and one skilled in the art would not use the teaching of Shimoda et al and combine it with the Murphy et al teaching since the membranes are completely non-analogous. The physical porosity of Shimoda et al would destroy the ability of the membrane to separate protons from electrons and therefore, the combination of the prior art in no way renders obvious Applicants' invention.

The Murphy et al patent teaches a membrane suitable for use as the electrolyte of a fuel cell and Murphy et al does not teach temperature conditioning to obtain heat resistance as Applicants'. In column 6, line 64 to column 7, line 11 quoted by the Examiner, this shows that the membranes filled with phosphotungstic acid are known to have improved temperature resistance properties since they retain water better. With respect to lines 37 to 44 of column 8 cited by the Examiner, Murphy et al does not teach anything but expresses a goal that "it would be desirable..." and there is no teaching whatsoever of any heat treatment. There is no suggestion whatsoever of Applicants' conversion of the amorphous phase to the crystalline phase. Therefore, the combination of the prior art completely fails to teach Applicants' invention and withdrawal of these grounds of rejection is requested.

With respect to the Examiner's comments concerning examples, Applicants would like to clarify what happens in the examples. In the Example 1, a membrane was prepared from a silica containing Nafion PFSA polymer and conditioned by a thermal ramp up to 160°C wherein said ramp produced a defined amount of crystallinity. The reference membrane is a plain unconditioned Nafion membrane and both membranes operate at 70°C but the conditioned membrane of Applicants' invention survived at 100°C while the reference membrane did not. It should be noted that the membrane was conditioned at a temperature of at least 5°C above its operating temperature as set forth in claim 12.

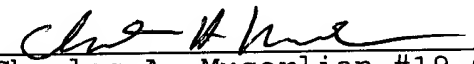
Example 2 compares the same two membranes under the influence of carbon monoxide and the reference Nafion membrane was inoperative. The inventive membrane did not run at 70°C, operate adequately at 100°C and ran well at 150°. Likewise, the membrane was conditioned at a temperature of at least 5°C above its operating temperature. With respect to Example 3, this compares silica filled membranes as in Example 1 with and without the thermal treatment at 160°C of Example 1. It clearly distinguishes the effects of the temperature conditioning alone. Operating with methanol at 85°C, the conditioned membrane produced 4 to 8 times the potential of the unconditioned membrane. At 155°C, the conditioned membrane of the invention operated well while the reference untreated membrane quickly became inoperative. The inventive membrane was conditioned at about 5°C above its maximum tested operating temperature.

With respect to Example 4, this compares the membranes of Example 3 but operating with ethanol and the results were the same. At 85°C, both membranes operated although at limited current. At 145°C, the conditioned membrane of the invention endured and the unconditioned membrane did not. The operating temperature was about 15°C less than the conditioning temperature. Example 5 describes the operation of a small "stack" comprising five units cells containing the conditioned membrane and the stack of cells was successfully operated with hydrogen and carbon monoxide at 85°C followed by water and methanol at 85°C and followed by water and

ethanol at 85°C. Therefore, it is clear that Applicants' invention clearly distinguishes from the prior art.

In view of the amendments to the claims and the above remarks, it is believed that the claims clearly point out Applicants' patentable contribution and favorable reconsideration of the application is requested.

Respectfully submitted,
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CAM:ds
Enclosures

MARKED UP VERSION OF CLAIMS SHOWING CHANGES MADE

Claim 12 (twice amended) A method for conditioning a polymeric proton exchange membrane for operation at temperatures above 100°C, the method comprising the steps of:

- a: heating the membrane to a temperature at least about 5°C above its said intended operating temperature;
- b: selecting a (desired)¹¹² percentage of conversion of the membrane polymer from an initial amorphous [state] phase to a crystalline [stage] phase;
- c: holding said membrane at an elevated temperature for a (predetermined)¹¹² interval, wherein the (predetermined) interval has been selected to permit the (desired) percentage conversion of amorphous to crystalline material; and
- d: returning the membrane to ambient temperature.